Material Informatics (MM 226)
Assignment 1- Data Curation Report
(Group 17)

Team Members:

1. **Vihaan Singh (230005051)**
   -Helped in finding Data
   -Code generation
2. **Vani Agarwal (230005050)**
   -Helped in finding Data
   -Report Making

Expanded Report: Mechanical Properties and Metadata of TWIP and TRIP Steels

1. Overview of Sources Used

The dataset has been curated from multiple peer-reviewed journal articles, each identified with a Digital Object Identifier (DOI) for precise referencing. These sources primarily focus on TWIP (Twinning-Induced Plasticity) and TRIP (Transformation-Induced Plasticity) steels, reflecting their mechanical properties and processing histories. Key references include:

- *JMEST: TWIP Steels - Mechanical and Metallurgical Properties - A Review* (DOI: JMESTN42353645)
- *Microstructure and Mechanical Properties of a New TWIP Steel* (DOI: 10.3390/ma18040890)
- *Effect of Deformation Temperature on Mechanical Properties and Deformation Mechanisms of Cold-Rolled Low C High Mn TRIP/TWIP Steel* (DOI: 10.3390/met8070476)

The dataset spans various processing conditions, including hot rolling, annealing, cold rolling, and microalloying, as well as diverse testing environments such as room temperature tensile tests and high strain rate testing.

2. Types of Data Collected

Mechanical Properties

The dataset includes key mechanical metrics relevant for automotive and structural applications:

- **Yield Strength (MPa)**: Resistance to plastic deformation; ranges from 200 MPa to 877 MPa across alloys.
- **Ultimate Tensile Strength (MPa):** Maximum load-bearing capacity; values range from 325 MPa to 1457 MPa.
- **Elongation (%):** Indicator of ductility; values vary significantly (35%-90%) depending on alloy composition and processing.
- **Strain Rate:** Tested under strain rates ranging from $0.001\ \mathrm{s}{-1}$ to $1000\ \mathrm{s}{-1}$ highlighting the steels' performance under dynamic conditions.

Microstructural Information

- Phases Reported: TWIP steels exhibit twinning mechanisms, while TRIP steels leverage martensitic transformations for enhanced mechanical properties.
- Alloy Variants: Includes first-generation TWIP steels (FeMnSiAl), second-generation TWIP steels (FeMnC), microalloyed variants with Al, Nb, or V additions.

Test Conditions

- Tests were conducted at temperatures ranging from $25 \circ \mathrm{C}$ to $600 \circ \mathrm{C}$ enabling insights into thermal stability.
- High strain rate testing was performed on select TWIP alloys to evaluate crashworthiness in automotive applications.

Metadata

Each alloy entry includes:

- Processing History: Details such as hot rolling, annealing, cold rolling, and microalloying.
- Testing Environment: Standard tensile tests at room temperature or elevated temperatures.

3. Missing Data and Identified Gaps

Despite the dataset's comprehensiveness, several limitations have been identified:

1. Incomplete Microstructural Quantification:
    - No quantitative metrics such as grain size or phase volume fractions are provided.
    - Lack of information on dislocation density or precipitate orientation critical for computational modeling.
2. Limited Advanced Mechanical Metrics:
    - No stress-strain curves, fatigue life data, or fracture toughness measurements are included.
    - These metrics are essential for durability analyses in structural applications.
3. Environmental Performance Data:
    - Corrosion resistance or behavior under extreme environments (e.g., salt spray or high humidity) is absent.

    - This data is crucial for assessing the steels' suitability in automotive or marine industries.
4. Hardness Data Missing:
    - Unlike the previous report on aluminum alloys, hardness values are not included here.
5. Duplicate Entries:
    - Some alloys appear multiple times under slightly varied conditions (e.g., TRIPTWIP_1 tested at different temperatures). While this provides valuable insights into thermal behavior, it may lead to confusion without clear differentiation.

4. Summary of Key Findings

The dataset highlights the versatility of TWIP and TRIP steels in terms of strength and ductility across varying processing conditions:

Alloy ID	Yield Strength (MPa)	Ultimate Tensile Strength (MPa)	Elongation (%)	Test Temperature ©	Strain Rate (s^-1)
TWIP_1	400	1000	50	25	0.001
TWIP_2	877	1457	55	25	0.001
TRIPTWIP_1	400	905	55	25	0.001
TRIPTWIP_1_600C	200	325	64	600	0.001
Nb_TWIP	480	1000	45	25	0.001